Potential Risks of Emerging and Reemerging Zoonoses

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ABSTACT

The global impact caused by diseases has had a predominant role throughout history, due to the loss of life, the economic implications and the social transformations produced at all times. Although at the beginning, the periods between one pandemic and another were very long, over the years this condition has changed. This is mainly due to the associated circumstances, initially wars, poverty, cultural practices, and deficiencies in health systems, created the ideal conditions for its manifestation. Currently, in addition to specific socioeconomic contexts, such as the demographic explosion, changes in land use, the invasion of natural habitats, changes in agricultural and livestock production, commercial exchange, international travel, hunting and consumption of wild animals, among other aspects, increase potential risk factors. Likewise, the emergence and re-emergence of zoonotic diseases are associated with the great evolutionary capacity of pathogens, which allows them to adapt to significant environmental changes, develop resistance to antimicrobials, diversify their hosts, and the appearance of new etiological agents or variants of existing ones and the increase in their harmful effects on health.

From the environmental aspect, the progressive alteration of natural habitats tends to break the balance in ecosystems, altering the population dynamics of the species that inhabit them, and promoting greater proximity of human beings to wild animals, natural reservoirs of many pathogens. Human disturbances to ecosystems due to excessive deforestation, establishment of monocultures, expansion of crop areas and livestock raising, increase in urbanization, among other factors, contribute significantly to increasing the risks of contracting zoonotic diseases. One of the main potential risks of zoonoses is the diversity of diseases and etiological agents involved. In addition to those already known, the evidence of the effects caused by hitherto unknown pathogens and their variants represents a potential problem for public health and animal health.

Keywords: Emergency, Re-emergence, Zoonotic diseases, Potential risks, Etiological agents.

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1. INTRODUCTION

Throughout history, one of the great challenges that humanity has faced is the emergence of diseases. The degree of affectation they generate depends on the etiological agent of disease, their transmission mechanisms, and the scope of the disease with respect to its distribution. Some appear suddenly and localized in certain places (epidemic outbreaks). There are diseases in which the significant increase in the number of cases, along with their active and rapid spread in a given geographical area (epidemics), generating greater effects. In others, it is recurring and constant appearance or its chronic prevalence in certain areas or age groups (endemic) which increases the levels of vulnerability of the population that suffers from them. While in those with the greatest scope and affectation (pandemics), transmission occurs within the communities themselves, simultaneously reaching a wide distribution in different continents, regions and countries of the world (Hortal 2016).

Due to the global impact, diseases have played a preponderant role in history. These are important due to the loss of life, the economic implications and the social transformations. The first recorded epidemic was the plague, which in 571AC devastated the city of Constantinople and caused the fall of the Byzantine Empire. 775 years later (1346, XIV century), the Black Death presented the worst outbreak since its appearance. It is the first deadliest pandemic in history, due to the number of deaths it caused in Europe, Asia and North Africa. A disease of zoonotic origin caused by the bacterium *Yersinia pestis*, transmitted by the bite of infected fleas, and spread by rats (WHO 2018). Currently, it continues to present sporadic outbreaks in Madagascar, the Democratic Republic of the Congo, and Peru. Smallpox was a zoonosis that affected *Homo sapiens* since prehistoric times. Its greatest expansion occurred in the XVIII century, significantly decimating the population. For the eradication of this disease, vaccination was very important, registering its last case in 1977 (Álvarez 2020; Huguet 2022).

Subsequently, at the end of World War II, in 1918 the first case of Spanish Flu appeared. The advance of military troops, the devastation caused by the war and social vulnerability appear as the main causes of expansion of this pandemic. The death toll increased due to insufficient medical services. Nearly 40 years later (1957), the first case of Asian flu caused by the influenza A (H2N2) virus appeared, becoming a pandemic in less than a year, associated with nearly one million deaths. Ten years later (1968), a new pandemic appears with the Hong Kong Flu, with the H3N2 variant of the influenza A virus, causing nearly one million deaths (Crespo 2022). In 1981, the first records of Human Immunodeficiency Virus (HIV) cases appeared. Since its appearance, this disease has affected millions of people and caused a large number of deaths throughout the world. Due to its scope and effects, it is a current pandemic, which is currently underway. 42 years after its identification, advances allowed it to be a treatable chronic disease, but there is still no cure (Naniche 2018).

Recently, in 2019, the first case of the pandemic produced by a new coronavirus (SARS-CoV-2), of zoonotic origin, appeared in the City of Wuhan (China). To date, it has not been possible to specify the intermediary animal. From the genomic comparison with the bat coronavirus (initially identified as a carrier), only 96.2% identical sequence was obtained (Zapatero and Barba 2023). This emerging pandemic has wreaked havoc on public health, as well as economic and social impacts. Until June 2023, the disease registered 689.7 million positive cases and 6.06 million deaths worldwide (TRT 2023). In July 2022, the first case of monkey pox (re-emerging zoonosis) was reported. Due to its worldwide distribution (in 110 countries), it is considered as a pandemic. Until June 2023, it registered 84,430 cases (PAHO/WHO 2023).

2. DISEASES, POTENTIAL RISKS AND CONTEXTS

Although epidemics such as Bovine Spongiform Encephalopathy (BSE), Severe Acute Respiratory Syndrome (SARS), MERS-CoV (Middle East Respiratory Syndrome), Ebola,

Dengue, Malaria are not included in this historical preamble, which have affected animals and humans (Wen-Hung et al. 2021).

Initially, the periods between one pandemic and another were very long. Between the Plague and the Black Death, seven centuries passed. Subsequent pandemics reduced their temporality to almost half a century and the recent ones (COVID-19 and Monkey pox) to less than a year. The circumstances (contexts) in which they appeared, such as war, poverty, environmental conditions, cultural practices and deficiencies in health systems are determining factors. Some diseases have remained endemic for long periods (viruses) and others as controlled diseases. A relevant aspect is that in recent pandemics diseases are associated with the emergence of new etiological agents and their variants, mainly viruses. Likewise, most of them are zoonotic in which wild species are involved (UNEP/IRLI 2020).

The convergence of social, cultural, economic and environmental factors is decisive in the appearance of zoonoses. The demographic explosion, changes in land use, the invasion of natural habitats, changes in agricultural and livestock production, commercial exchange, international travel, hunting and consumption of wild animals increase the risk factors (UNEP/IRLI 2020). These circumstances introduce modifications in the local contexts, altering the balances between pathogens and hosts. As a result, the ecological plasticity of pathogens promotes the appearance of variants associated with physical and biological environmental changes, which translates into a greater diversification of reservoirs and hosts, and an increase in diseases (Ariza 2016; Lorenzo et al. 2017).

Under these conditions, the potential risks increase and with it, the probability of the re-emergence and emergence of diseases increases that affect the health of humans and animals. Thus, the etiological agent-host-environment interaction is decisive. The great capacity for evolution of pathogens allows them to adapt to significant environmental changes, develop resistance to antimicrobials, diversify their hosts and increase their harmful effects on health. Changes in environmental conditions make originally hidden zoonoses (mainly in tropical areas where there is a greater diversity of mammals) begin to manifest with different levels of scope. The deterioration of natural habitats due to the occurrence of extreme weather events causes the displacement of wild species, a reservoir of pathogens confined to certain habitats, favoring the spread of diseases to peri-urban and urban areas. Although not all of these zoonoses can become pandemics, the truth is that the vast majority of pandemics originate as zoonoses (Losa 2021).

3. ENVIRONMENTAL DAMAGE AND PATHOGENS

One of the main causes of the increase in diseases is environmental damage. The alteration of natural habitats breaks the balance in the ecosystems, alters the population dynamics of the species that inhabit them and promotes a greater proximity of the human being with wild animals that are natural reservoirs of many pathogens. Human disturbances to ecosystems due to immoderate deforestation, establishment of monocultures, expansion of cultivation areas and cattle raising and increase in urbanization contribute to increasing the risks of contracting diseases (Alonso et al. 2022).

In addition to the consequences faced by events associated with climate change, the most significant consequence of environmental damage is the loss of biodiversity. By reducing the number of species, the risk of new diseases increases due to the exposure of the remaining species to new pathogens. The low specificity of pathogens for non-human hosts, their high biological flexibility, capacities and resistance are leading to an increase in zoonoses (García-Rubio et al. 2023).

UN/IRLI (2020) warned about the significant increase in zoonoses. They estimated that around 60% of new diseases in humans have a zoonotic origin. While 75% of new diseases

are associated with this origin, which highlights the close relationship between diseases and ecosystem health. Climate change, the loss of ecosystems and their biodiversity will continue to cause the emergence of new pandemics. A determining factor to preserve the health of humans and animals is to conserve biodiversity (IPBES 2019).

In addition to the diversification of hosts, the risks of zoonoses increase due to the diversity of pathogen transmission routes and the dispersal capacities of some reservoirs. Although in zoonoses, the reservoirs can be all vertebrates, the mammals play a fundamental role in the maintenance, transmission and spread of pathogens. The progressive exposure to natural habitats and proximity to wild species is increasing the risks. The role of bats and rodents as reservoirs of emerging zoonotic viruses stands out. In the case of wild rodents, displacement to nearby rural areas is increasing direct contagion through feces, urine, or other excretions or through vector transmission. This causes domestic species to be exposed and the disease spreads from wild rodents to humans (Monsalve et al. 2009; Torres-Castro 2017).

4. CURRENT APPROACH TO EMERGING AND RE-EMERGING ZOONOSES

One of the main potential risks of zoonoses is the diversity of diseases and etiological agents involved. In addition to those that are already known, the evidence of the effects caused by unknown pathogens and their variants means a potential problem for public and animal health (Rebollo et al. 2021).

Of the 182 diseases integrated in the World Health Information System (WAHIS) of the World Organization for Animal Health, 62 (34.06%) are identified as zoonoses. 29 are caused by bacteria, 22 by viruses (3 by rotavirus and 1 by Coronavirus), 4 by parasites, 1 by prion, 4 by protozoa and 2 by Rickettsia (WHO 2023). According to the report on emerging diseases (reported for the first time in some locations) for the period 2005-2023, information is recorded for 17 different zoonoses. According to the regions considered by the WOAH, 7 different zoonoses are identified for Africa, the Americas and Europe, 10 for Asia and 3 for Oceania. The largest total number of localities with registration is Europe (40). The zoonoses with the highest frequency are SARS-CoV (33), West Nile fever (16) and Newcastle disease (11) (Table 1).

Table 1: Emerging zoonoses by WHO region (2005-2022)

ZOONOSES	AFRICA	AMERICAS	ASIA	EUROPE	OCEANIA	Total reports/ zoonoses
Anthrax	2		3	2		7
Brucellosis (*Brucella suis*)				1		1
Avian chlamydiosis			1		1	2
Japanese encephalitis					1	1
Equine encephalomyelitis		2				2
Foot and mouth disease	8		1			9
West Nile fever	2	2	1	11		16
Rift Valley fever	5					5
Q-Fever				2		2
Leishmaniosis		1	2		1	4
Glanders			3			3
Newcastle	1	2	1	7		11
Rabies	2	1	4			7
SARS-CoV in animals	2	9	6	16		33
Trypanosomiasis		2				2
Tularemia				1		1
Camel pox			1			1
Different zoonoses	7	7	10	7	3	98
Total reports/region	20	8	16	23	3	70

Source: Own elaboration based on the processing of information from WOAH (2023)

The SARS-CoV with reports for 2020-2022, is emerging worldwide. The rest of zoonoses have previous records in other locations. For each zoonoses, the number of sick animals depends on the number of specimens, the prevention, control and follow-up measures and the breeding conditions. As an example, the analysis of Anthrax allows us to show the regional differences that may occur. In the last two years, it appears as emerging zoonoses in two locations in Kyrgyzstan (2022 and 2023) and one in Kazakhstan (2023). 1 positive case and 500 dead animals registered from Kyrgyzstan in 2022. The analysis of the general behavior shows the impact generated by this disease (Table 2).

Table 2: Cases of anthrax in animals by world region (2005-2022)

REGIÓN	DOMESTIC								WILD		
	Cattle		Sheep		Goats		Equines				
	Cases +	Deaths	Cases +	Deaths	Cases +	Deaths	Cases +	Deaths	NAE	Cases +	Deaths
Africa	95,801	11,376,660	42,702	2,297,770	11,957	736,877	9,560	1,053,359	32	5,268	47,670
Americas	5,017	237,901	245	10,950	20	57,411	74	541	4	1,111	2,225
Asia	15,512	6,330,078	26,473	6,670,603	3,006	353,073	392	18,606	7	1,071	352,795
Europe	1,283	2,148,862	2,250	1,946,006	103	20,922	33	11,714	10	2,716	142,358
Oceania	474	20,963	1,470	51,155	1	1					
Totals	118,087	20,114,464	73,140	10,976,484	15,087	1,168,284	10,059	1,084,220	42*	10,166	545,048

NAE= Number of affected species: * Considered different species: Source: Own elaboration based on the processing of information from WOAH (2023)

The positive cases and deaths produced make it evident that despite the strategies promoted by international agencies, preventive measures such as vaccination and control measures implemented, the disease continues to be out of control. In addition to these indicators, the recent appearance of emerging zoonoses in new locations in three regions of the world (Africa, Asia and Europe) reflects the current situation. The registration of a greater number of deaths compared to the positive cases gives indications of the absence of a timely diagnosis. This situation represents a serious risk in transmission (WOAH 2023).

The implications in terms of risk are oriented towards the fact that this disease can expand its distribution and continue to affect animals and people. In terms of impact, the large economic losses generated by the death of animals have an equal impact on food security. The largest number of deaths (32'259,232) corresponds to livestock species such as cattle, sheep, and goats, which are the basis of food in many locations. The problem tends to worsen when it sells the meat of animals that suffer from or died of the disease. The consumption of contaminated meat is one of the routes of contagion to humans, due to improper cooking processes. The affectation in domestic species (89 deaths in dogs and 19 in domestic cats were excluded) and 42 species of wild animals shows the magnitude of the problem that is faced only with this zoonoses.

This is not exclusive to these zoonoses. According to estimates, domestic animals share an average of 19 zoonotic viruses with humans, while for wild species the average is 0.23. This relationship means that a large proportion of zoonotic diseases involve domestic animals, poultry, pigs, cattle and sheep, mainly (UNEP/IRLI 2020).

Whether they appear for the first time in a locality, their incidence and infectiousness increases, or they adopt new forms of transmission. Emerging zoonoses represent a potential risk, due to the problem involved in combating them and the effects they can cause on animal and human health. By 2020, in the European Union, 364,260 patients associated with 24 different zoonoses were registered. Of this total, 18,134 required hospitalizations, registering 465 deaths and the majority (168) due to listeriosis (Table 3).

When comparing the frequencies reported for some of these zoonoses in animals and humans in the European Union, some aspects stand out (Table 4). In terms of correspondence of information in WAHIS (WOAH 2023), not all zoonoses are included in the list of diseases. Of the 24 zoonoses identified in humans, only 9 have been reported in animals. Even considering that those transmitted by vectors, by direct contact with soil contaminated with the pathogen (tetanus), or by the consumption of contaminated food, bovine tuberculosis, for example, has no records for that year. For some zoonoses, the registries only report information up to 2011 (such as Leptospirosis).

Table 3: Cases of zoonoses in humans in the European Union (2020)

ZOONOSES	Positive cases	Hospitalized	No. of deaths
Anthrax	3	2	1
Botulism	80	29	0
Brucellosis	132	38	2
Campylobacteriosis	120,544	8,605	45
Crimean-Congo hemorrhagic fever	132	38	2
Zoonotic chlamydiosis	161,984	0	0
Cryptosporidiosis	3,674	192	0
Equinococcosis	544	44	0
Giardiasis	6,252	179	0
Hantavirus infection	1,640	301	16
Leptospirosis	569	239	6
Listeriosis	1,887	775	168
Lyme Disease	740	2	0
Q-Fever	528	0	0
Rabies	0	0	0
Salmonellosis	52,690	6,450	61
Tick-borne encephalitis	3,699	408	62
Tetanus	32	8	5
Toxoplasmosis	133	21	5
Trichinosis	117	16	0
Tuberculosis	3,380	103	79
Tularemia	678	0	0
STEC/VTEC Infection	4,489	673	13
West Nile fever	333	11	0
Totals	364,260	18,134	465

Source: Own elaboration based on ECDC data processing (2023)

Table 4: Comparison of the effects of zoonoses in animals and humans. (European Union, 2020)

ZOONOSES	HUMANS			ANIMALS			
	Positive cases	Hospitalized	Deaths	Positive cases	Eliminados	Sacrificados para venta	Deaths
Anthrax	3	2	1	7	1	1	6
Brucellosis	132	38	2	16,563	151	8,505	0
Zoonotic chlamydiosis	161,984	0	0	404	0	0	47
Q-Fever	528	0	0	1,665	1	1	14
Rabies	0	0	0	13	4	0	9
Salmonellosis	52,690	6,450	61	331	2	40	0
Trichinosis	117	16	0	1,091	128	78	0
Tularemia	678	0	0	211	0	0	49
West Nile fever	333	11	0	434	6	6	95
Totales	216,465	6,517	64	20,719	293	8,631	220

Source: Own elaboration based on data processing from ECDC (2023) and WOAH (2023)

Based on these data, they show the differential effects of zoonoses in animals and humans. Additionally, it reflects how the control of some diseases prevents contagion to humans, such as rabies. For Chlamydiosis, positive cases in humans significantly exceed that in animals. By way of transmission, a single bird (especially pigeons) may be spreading the disease to a larger number of people. In the case of salmonellosis, different domestic species are carriers of the bacteria, increasing the possibility of contamination of water and food sources due to deposit of their feces. The irrigation of vegetables with contaminated water, together with inadequate disinfection, expands the transmission of the disease together with the consumption of contaminated meat with poor cooking or contact with infected people and animals. Deaths are generally the consequence of profuse diarrhea, dehydration and toxemia (CFSPH 2005).

Despite the fact that WAHIS (WOAH 2023) integrates information on different diseases, the records are incomplete. There are diseases that are not included in the database and others that do not have recent records. This consideration is relevant to avoid false interpretations. In the first case, the absence of records do not imply the absence of the disease; and in the second, that only up to the reporting year (such as Listeriosis, which only has records up to 2011), is that the disease remained in force. The lack of information decreases the opportunities to implement preventive actions and timely care. In the case of humans, only the European Union has reports that integrate the behavior of different diseases, which enables greater control (ECDC 2023).

Although for many of the zoonoses reported as emerging in some localities, the history of the disease makes it possible to activate response mechanisms to control them. The risks increase exponentially when it comes to newly emerging diseases. As happened at the time with Ebola, which presented its first outbreak in 1976 in the Democratic Republic of the Congo (PAHO/WHO 2019). The appearance of Legionellosis in 1977 with the infection of those attending the 58th Convention of the American Legion (Ferrer 2022). The first cases of HIV were detected in 1981 in Los Angeles and New York in the early 1980s (Carrillo and Villegas 2004), and recently COVID-19 (TRT 2023).

As emerging zoonoses, COVID-19 pandemic has generated great health effects. For animals, records from 2020-2022 are available. They include 8 countries from the Americas (Argentina, Brazil, Canada, Chile, Colombia, Ecuador, the United States, Mexico and Uruguay), 1 from Africa (City of Johannesburg, South Africa), 4 from Asia (Hong Kong, Japan, Myanmar and Thailand), 5 from Europe (Bosnia and Herzegovina, Croatia, Finland, United Kingdom and Switzerland) and no reports for Oceania. Affected species include 22 wild and 2 domestic animals. Dogs with a higher number of cases (139) than cats (91). Mustelids register the highest number of cases (239). In the wild animals, white-tailed deer (48), tigers (29), lions (27), gorillas (13), and snow leopards (10) are important (WOAH 2023).

In humans, until June 2023, the total number of positive cases was 689,756,705, the number of deaths 6,067,072 (0.88%), recovered 620,405,865 (89.95%) and active 59,584,453 (8.64%) around the world (Table 5) (TRT 2023; WHO 2023).

Table 5: Accumulated records for COVID-19 at the regional level (Report as of June 30, 2023)

Region	Affected countries	Cases	Deaths	Recovered	Active cases
African	51	9,225,847	185,770	9,354,921	369,525
Americas	49	195,757,193	2,961,675	188,412,934	2,841,469
Southeast Asia	16	69,108,292	327,366	67,388,851	308,070
European	63	278,083,268	1,943,044	255,277,243	19,091,349
Eastern Mediterranean	20	21,455,914	332,140	19,795,968	1,337,679
Western Pacific	31	116,126,191	317,077	80,175,948	35,636,361
Totals	**230**	**689,756,705**	**6,067,072**	**620,405,865**	**59,584,453**

Source: Own elaboration based on the processing of data taken from WHO (2023) and TRT (2023)

The total of the percentage values is 99.46%, with a difference of 3,699,315. The comparison of the information reported for Mexico (TRT) and that registered by CentroGeo (2023) which shows the same number of cases (7,633,355), deaths (334,336) and recoveries (6,885,378); however, there are differences in the number of active cases 413,641 (TRT 2023) versus 3,558 (CentroGeo 2023), so it is inferred that the differences are associated with this indicator.

According to TRT (2023) worldwide, the United States (107,352,160) followed by India (44,994,407) and France (40,138,560), are the countries that have accumulated the highest number of cases since the start of the pandemic. Based on the WHO division, at the regional level the highest values correspond to the European Region (278.08 million), the Americas (195.76 million) and the Eastern Pacific (116.13 million). By regions, the countries with the highest number of cases include South Africa, Lebanon and Zambia from African Region, United States, Brazil and Argentina from Americas, India, Indonesia and North Korea from Southeast Asia, France, Germany and Italy from European Region, Iran, Iraq and Jordan from Eastern Mediterranean region and Japan, South Korea and Australia from Western Pacific region.

The behavior of the pandemic presents variations in different countries and regions. The registered deaths with respect to the number of cases in addition to the relationship between these two variables reflect other relevant aspects. The United States with the highest number of registered cases, and 1,168,485 deaths, only reaches a 1.09% mortality rate. In contrast, Aruba with 442 cases and 236 deaths has a mortality rate of 53.39%, recognized as the highest worldwide. However, a more specific appreciation of the impact of the pandemic derives from correlating the population data with the number of cases and deaths to reflect its real impact. The ten countries with the highest number of cases and the highest number of deaths are included (Table 6).

In official reports, the main indicator has been the number of cases reported, to which the number of deaths is associated. From the calculation of the percentage proportion of these two indicators, although the United States reports the highest number of cases, the highest percentage of deaths corresponds to Brazil (1.87%). The same happens with the countries with highest percentage of mortality, where the highest value corresponds to Ethiopia (7,574 cases) but the highest percentage to Aruba (53.39%) (TRT 2023).

To show the variations, the population data of 2020 (year in which the death report begins) is taken as a reference. Due to the number of cases, the most affected populations are South Korea with a population density of 515 inhabitants/km^2 (62.23%), France 124 inhabitants/km^2 (59.33%) and Germany 234 inhabitants/km^2 (46.21%). Regarding the countries with the highest percentage of mortality, both for the number of cases and for the number of registered deaths; the list is headed by Ethiopia. By direct relationship, the highest percentage corresponds to Aruba. When relating these indicators to the population, the highest percentage of affected population is for Bermuda (2.95%) with a population density of 1,201 inhabitant/km^2 (WB 2023).

As can be seen, demographic data paints a different picture. India in second place by the number of cases (44.9 million), reports 0.12% mortality. Although the affected population is 3.22%, it is necessary to consider that its total population is just over 1.396 million inhabitants, with a density of 428 inhabitant/km^2. This data shows that the differences in the behavior of zoonoses are associated with population characteristics, which as a risk factor in the transmission of zoonoses, are of great relevance (TRT 2023).

On the other hand, re-emerging diseases correspond to those apparently controlled, and which cease to represent a health problem. However, under certain conditions these sometimes reappear with more severe ranges than with which these started. Therefore, these diseases represent a serious health threat. Diseases such as dengue, yellow fever, cerebrospinal meningitis, cholera, are some examples of these type of diseases (Rebollo et al. 2021).

Table 6: Impact of COVID-19 on the number of cases and deaths vs. population reported in 2020

Countries	Cases	Death	% Mortality	Population 2020	Population Density Inhabitants/km^2	% of affected population
COUNTRIES WITH THE HIGHEST NUMBER OF CASES						
USA	107,352,160	1,168,485	1.09	331,257,000	34	32.41
India	44,994,407	53,191	0.12	1,396,387,127	428	3.22
France	40,138,560	167,642	0.42	67,656,682	124	59.33
Germany	38,428,685	174,352	0.45	83,155,031	234	46.21
Brazil	37,682,660	704,159	1.87	211,756,000	25	17.80
Japan	33,803,572	74,694	0.22	125,849,000	332	26.86
South Korea	32,256,154	35,071	0.11	51,836,000	515	62.23
Italy	25,897,801	190,868	0.74	59,236,213	195	43.72
United Kingdom	24,636,637	227,524	0.92	67,081,000	275	36.73
Russia	22,963,688	399,649	1.74	146,171,000	9	15.71
COUNTRIES WITH THE HIGHEST PERCENTAGE OF DEATHS						
Aruba	442	236	53.39	106,585	595	0.41
Liberia	809	295	36.46	5,058,000	47	0.02
Malawi	8,877	2,686	30.26	19,377,061	168	0.05
Namibia	17,131	4,091	23.88	2,504,000	3	0.68
Lesotho	3,479	723	20.78	2,254,100	75	0.15
Yemen	11,945	2,159	18.07	31,927,000	63	0.04
Cameroon	12,509	1,974	15.78	26,546,000	59	0.05
Ethiopia	50,092	7,574	15.12	99,700,000	90	0.05
Djibouti	1,569	189	12.05	988, 000	43	0.16
Bermuda	1,886	165	8.75	63,893	1,201	2.95

Source: Own elaboration based on the processing of data taken from Expansión (2023), TRT (2023) and WB (2023)

Biological factors such as the expansion in the distribution of pathogens, their variability and genetic adaptability, the diversification of reservoirs and the reproductive capacity of the vectors are determining factors. Those of an anthropogenic nature include the effects caused in the environment such as climate change and environmental deterioration. Those of a socio-economic type (poverty, marginalization, overpopulation) tend to harm populations in certain regions. In general, these involve problems of systems management and measures to prevent and control diseases. These include deficiencies in sanitary systems, water supply and sanitation, as well as epidemiological surveillance and vector control. The set of these biological, anthropogenic and socio-economic factors are the main causes of the reemergence of diseases (Arredondo and Amores 2009; Hortal 2016).

The effects of these diseases can be localized, manifesting as outbreaks or endemic in some locations, or generate greater impacts due to their wide distribution and affected species. As latent risks, it is unpredictable to determine a new occurrence of the disease. When they do, despite previous experience, control is often difficult in cases where epidemiological surveillance is inadequate, contributing to the global public health burden (Suberbiel et al. 2017).

Of the recent re-emerging zoonotic cases, monkey pox stands out to be an important landmark. A disease that was first detected in humans in 1970 in the Democratic Republic of the Congo (DRC) and spread to other African countries (Cameroon, Ivory Coast, Liberia, Nigeria and Sierra Leone). The total number of cases reported in that year was 48 (36 for the DRC). In 1980, the number of cases increased significantly in the DRC (343) and 14 more cases occurred in the Central African Republic, 4 cases in Gabon and 1 each in Ivory Coast and Cameroon. In 1990, the cases continued to increase with 511 for DRC and 9 for Gabon. In 2003, in addition to continuing the cases in African countries, there was an outbreak in the United States with 47

cases, the only report outside of Africa. In Africa, in some countries the cases have been significantly reduced (Bunge et al. 2022). According to the WOAH, this disease occurs mainly in the African rainforest, and can sometimes be present in other regions of the world. In WAHIS, there is only one record for 2014 in Cameroon, with 6 positive cases in chimpanzees. In 2022, the zoonoses occurs in a pig farm in Boende, Domaine locality in the Democratic Republic of the Congo, which affects 16 animals and causes the death of two piglets (WOAH 2022).
The current reemergence of these zoonoses is generating greater impacts, which led to the WHO declaring it an international public health emergency in July 2022. The first outbreaks occurred in Canada and the United States, and on the Iberian Peninsula, in Spain and Portugal. As of June 2023, 84,430 cases have accumulated in 110 countries around the world and 119 deaths in the Americas. The highest figures correspond to the United States (43), Mexico (30) and Peru (20). Table 7 shows the accumulated data of monkey pox disease by WHO regions (PAHO/WHO 2023).

Table 7: Cumulative cases of Monkey pox in humans by world regions according to the WHO (2022-2023).

Region	Affected countries	Countries without case reports	Cases	Deaths	Countries with the highest number of registered cases
African	12	37	1,770		Nigeria (843), Congo (675) and Ghana (127)
Americas	31	12	55,887	119	United States (30,324), Brazil (10,961) and Mexico (4,031)
Southeast Asia	6	5	201		Korea (117), Thailand (56) and India (22)
European	44	14	25,912		Spain (7,559), France (4,146) and United Kingdom (3753)
Eastern Mediterranean	10	13	63		Sudan (19), United Arab Emirates (16) and Saudi Arabia (8)
Western Pacific	7	21	597		China (194), Japan (158) and Australia (145)
Totals	110		84,430	119	

Source: Own elaboration based on the processing of data taken from PAHO/WHO (2023)

It is noteworthy that the number of cases significantly exceeds previous reports of these zoonoses. With this, the consideration of the WOAH of being a disease that occurs mainly in countries of the African continent, and occasionally in other regions, is no longer applicable. The evolution of zoonoses in different regions and the gradual increase in affected countries is alarming (PAHO/WHO 2023).

5. DETERMINANTS AND POTENTIAL RISKS FOR ZOONOSES

The data shown, especially on the effects caused by the COVID-10 emergency and the reemergence of monkey pox, lead to the inference that under current conditions, potential risks tend to increase. In addition to the high probability that new diseases will emerge, there is also the possibility that endemic diseases widen their distribution or those considered controlled and even eradicated, may reappear with effects that are more significant (Rebollo et al. 2021).
The reference to "current conditions" is not limited to increasingly deteriorating and changing environmental conditions. Although environmental deterioration, climate change and the loss of biodiversity stand as possible conditions for the emergence of new diseases, various factors are also contributing to this problem. In general, they range from those inherent to the pathogens themselves, their vectors and reservoirs, to those that are clearly anthropogenic (IPBES 2019).

The multiplicity of factors associated with the potential risks for the emergence and re-emergence of diseases (most of a zoonotic nature) make it impossible to list each one. However, the indication of the main factors and associated risks will allow us to infer the complexity of the problem (UNEP/IRLI 2020).

6. ENVIRONMENTAL FACTORS

- Environmental deterioration is causing significant alterations in 75% of the land surface, 66% in the ocean and the loss of 85% of wetlands, which increases the number of threatened plant and animal species (IPBES 2019).
- Alterations in ecosystems contribute to the displacement of wild reservoirs, causing contact with domestic species and the emergence of zoonoses (Keesing et al. 2010).
- The increase in deforestation benefits the propagation of vectors and the transmission of diseases (IPBES 2019).
- Alterations in natural cycles and environmental stability produced by climate change increase the risks of zoonotic overflows and the emergence of epidemics (Sánchez 2021).
- Global warming and changes in rainfall are promoting the expansion of the geographic range of vectors and the spread of diseases (Mora et al. 2022).
- Variations in temperature increase vector populations and favor the life cycles of pathogens (Alonso et al. 2022).
- The increase in the emission of greenhouse gases (GHG) is aggravating 58% of diseases in animals and humans (Mora et al. 2022).
- The fragmentation of forests and jungles displaces rodent predators (pathogen reservoirs) (IPBES 2019).
- The sustainability of the species is at risk, affecting not only ecosystem functions, but also promoting the spread of pathogens (IPBES 2019).
- The loss of biodiversity extends the risks for disease transmission (Keesing et al. 2010).
- High temperatures or extreme environmental conditions increase host immunosuppression, favoring the development of diseases (Sánchez 2021).

7. FACTORS ASSOCIATED WITH PATHOGENS

- About 80% of pathogens can affect more than one animal species (multi-host) (Gortázar et al. 2007).
- Zoonotic viruses express a high genetic evolution and formation of highly infectious lineages (Bunge et al. 2022)
- Current human influenza viruses tend to be increasingly pathogenic because of a complex evolution associated with the mixing of viruses in domestic animals, mainly birds and pigs (UNEP/IRLI 2020).
- Increased resistance to antimicrobials (Hortal 2016).
- Pathogens that spread via the respiratory route have fewer barriers to spread from one host to another (IPBES 2019).
- Indirect zoonoses such as Zika, yellow fever and West Nile fever (reemerging) are becoming endemic in different regions of the world, due to the capabilities developed by pathogens (UNEP/IRLI 2020).

8. HOSTS AND RESERVOIRS

- Biological communities are increasingly similar, which are increasing their vulnerability to zoonoses (IPBES 2019).

- A significant number of diseases are under control in domestic species, but remain dormant in wild reservoirs (Gortázar et al. 2007).
- There is a higher viral load in animals with greater resilience to environmental changes (Ariza 2016).
- The translocations of wild and domestic animals represent risk factors for the appearance of zoonoses (Gortázar et al. 2007).
- Domestic and wild peridomestic species can function as transmitters of diseases to humans (UNEP/IRLI 2020).
- Host susceptibility associated with health status, sex, age, nutritional status, exposure history, genetics and immunocompetence that is decisive in the evolution of the disease (Ariza 2016).

9. TRIGGERING HUMAN FACTORS

- Population growth favors the appearance of misery belts in the urban periphery, susceptible to a greater diffusion of existing diseases and the emergence of others (Cabezas-Sánchez 2015).
- Unsustainable use of natural resources due to changes in land use, urbanization, agricultural and extractive activities (IPBES 2019).
- Development problems including poverty, marginalization, scarcity of drinking water, political and food insecurity and high dependence on livestock and wild animals as resources for subsistence (Suberbiel et al. 2017).
- Unsustainable agricultural intensification (more animals, genetically homogeneous and equally susceptible populations) that increases the risks of zoonoses (Rebollo et al. 2021).
- International travel and commercial exchange of food. Diseases move around the world in times less than the incubation periods (Wen-Hung et al. 2021).
- Increased intrusion into natural habitats, leading to increased contact between wildlife, livestock, and humans (Wen-Hung et al. 2021).
- Increase in the use and exploitation of wild species, due to increase in the consumption of game meat, sport hunting, animal trade, decorative products and medicinal uses (Monsalve et al. 2009).
- Expansion of informal markets that sell wild animals for human consumption without regulation, as well as deficiencies in processing plants (Losa 2021).
- Modifications in food supply chains that generate cross contamination, traceability problems and an increase in foodborne diseases (Rebollo et al. 2021).

10. PROBLEMS IN THE MANAGEMENT OF HUMAN AND ANIMAL HEALTH

- Zoonotic diseases of wild animals are generally not included in monitoring programs, despite of the fact that 70% of human diseases come from these species (Ruiz et al. 2010).
- The trade in wild animals increases the possibilities for the evolution of pathogens and the spread of zoonoses (WOAH 2015).
- Deficiencies in the biosecurity of livestock production systems can favor the emergence of zoonotic variants. For example, in Rift Valley fever cattle have functioned as an amplifying host for the virus that originally circulated in vectors such as mosquitoes and in wild species and now operates as a zoonotic virus (IPBES 2019).
- Countries with deficient health systems and epidemiological surveillance are especially vulnerable to zoonoses (WOAH 2015).

- There is a significant number of neglected zoonoses, widely distributed in developing countries, which increases the vulnerability of the population to contract other types of diseases (Ramírez 2012).
- The demographic explosion, livestock overproduction and the increase in pests have reduced the populations of wild animals and increased the risks for domestic animals and humans to participate as incidental hosts (Losa 2021).
- Foodborne zoonoses with a high epidemiological burden and greater impact on vulnerable communities, increase neglected zoonoses (Ramírez 2012).
- Deficient epidemiological surveillance (Rebollo et al. 2021).

11. CONCLUSIONS

The diversity of factors associated with the emergence and reemergence of zoonoses leads to the recognition that the potential risks are diverse and complex. Reversing or at least mitigating many of them (such as climate change), is a complex task and perhaps for many, it is impossible to achieve. Recent experiences, particularly with COVID and monkey pox, show not only the vulnerability, but also the uncertainty in which we currently live. The deficiencies in controlling them, the inability to address them and impede their progress, the exponential growth of deaths and the costs that they have meant, underscore the importance of addressing this problem proactively rather than reactively. The recognition of the multiple interrelationships that exist between animals, humans and the environment is unavoidable to deal more effectively with this problem. The One Health strategy that is being promoted seeks to address these aspects in a comprehensive and transversal manner, as an alternative to face the health risks that are currently faced in order to propose efficient measures that guarantee a better future.

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